Universitat Autònoma de Barcelona

2021/2022

Introduction to Human and Computer Vision

Code: 43085
ECTS Credits: 6

Degree	Type	Year	Semester
4314099 Computer Vision	OB	0	1

The proposed teaching and assessment methodology that appear in the guide may be subject to changes as a result of the restrictions to face-to-face class attendance imposed by the health authorities.

Contact

Name: Maria Vanrell Martorell

Email: Maria.Vanrell@uab.cat

Use of Languages

Principal working language: english (eng)

Teachers

Javier Vazquez Corral

Javier Ruiz Hidalgo

Ramon Morros Rubio

Verónica Vilaplana Besler

Philippe Salembier Clairon

Prerequisites

Degree in Engineering, Maths, Physics or similar

Objectives and Contextualisation

Module Coordinator: Dr. Philippe Salembier

The aim of this module is introduce the students to computer vision including basics of human visual system and image perception, acquisition and processing. In terms of processing, the module deals with low-level pixel-based transforms, linear, nonlinear and morphological filtering, Fourier analysis, multiscale representations, extraction of simple features and image descriptions. Furthermore, elementary grouping, segmentation and classification strategies will be discussed as well as quality and assessment methodologies for image processing algorithms. To put into practice the algorithms and techniques, the students will work on a concrete project along the course. The aim is to provide an applied knowledge of a broad variety of Computer Vision techniques applied to solve a real-world vision problem. The project goal is to detect specific objects in images using basic CV techniques such as linear and non-linear filtering segmentation, grouping, template matching, modeling, etc. The knowledge obtained can be used in a wide variety of applications, for instance, quality control, generic object detection, security applications, etc.

Competences

- Accept responsibilities for information and knowledge management.

- Choose the most suitable software tools and training sets for developing solutions to problems in computer vision.
- Conceptualise alternatives to complex solutions for vision problems and create prototypes to show the validity of the system proposed.
- Continue the learning process, to a large extent autonomously.
- Identify concepts and apply the most appropriate fundamental techniques for solving basic problems in computer vision.
- Plan, develop, evaluate and manage solutions for projects in the different areas of computer vision.
- Solve problems in new or little-known situations within broader (or multidisciplinary) contexts related to the field of study.
- Understand, analyse and synthesise advanced knowledge in the area, and put forward innovative ideas.
- Use acquired knowledge as a basis for originality in the application of ideas, often in a research context.
- Work in multidisciplinary teams.

Learning Outcomes

1. Accept responsibilities for information and knowledge management.
2. Choose low-level techniques for detecting and grouping characteristics and train them to resolve a specific project.
3. Continue the learning process, to a large extent autonomously.
4. Identify and suitably apply the low-level techniques of vision systems, namely the extraction and grouping of characteristics.
5. Identify the best definable representations for extracting and grouping characteristics in specific projects.
6. Relate the basic techniques in computer vision to the processing that takes place in the human visual system human.
7. Solve problems in new or little-known situations within broader (or multidisciplinary) contexts related to the field of study.
8. Understand, analyse and synthesise advanced knowledge in the area, and put forward innovative ideas.
9. Use acquired knowledge as a basis for originality in the application of ideas, often in a research context.
10. Use low-level processing techniques to plan, develop, evaluate and manage a solution to a particular problem.
11. Work in multidisciplinary teams.

Content

1. Human visual system and perception
2. Image formation and color representation
3. Image processing assessment and pixel-based processing
4. Morphological and nonlinear filtering
5. Space-frequency representation, Fourier transform and linear filtering (I)
6. Space-frequency representation, Fourier transform and linear filtering (II)
7. Scale-space theory and multi-scales image processing
8. Feature extraction
9. Grouping, Segmentation and Classification

Methodology

Supervised sessions: *(some of these sessions could be online synchronous)*
• Lecture Sessions, where the lecturers will explain general contents about the topics. Some of them will be used to solve the problems.

Directed sessions:
• Project Sessions, where the problems and goals of the projects will be presented and discussed, students will interact with the project coordinator about problems and ideas on solving the project (approx. 1 hour/week).
• Presentation Session, where the students give an oral presentation about how they have solved the project and a demo of the results.
• Exam Session, where the students are evaluated individually. Knowledge achievements and problem-solving skills

Autonomous work:
• Student will autonomously study and work with the materials derived from the lectures.
• Student will work in groups to solve the problems of the projects with deliverables:
• Code
• Reports
• Oral presentations

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Lecture Sessions	20	0.8	4, 5, 7, 6, 2, 9, 10
Type: Supervised			
Supervised sessions	8	0.32	1, 8, 4, 5, 7, 3, 2, 9, 11, 10
Type: Autonomous			
Homework	113	4.52	1, 8, 4, 5, 7, 3, 2, 9, 11, 10

Assessment

The final marks for this module will be computed with the following formula:

Final Mark = 0.4 x Exam + 0.55 x Project+ 0.05 x Attendance

where,

Exam: is the mark obtained in the Module Exam (must be >= 3).

Attendance: is the mark derived from the control of attendance at lectures (minimum 70%)

Project: is the mark provided by the project coordinator based on the weekly follow-up of the project and deliverables (must be >= 5). All accordingly with specific criteria such as:

- Participation in discussion sessions and in team work (inter-member evaluations)
- Delivery of mandatory and optional exercises.
- Code development (style, comments, etc.)
- Report (justification of the decisions in your project development)
- Presentation (Talk and demonstrations on your project)

Only those students that fail (Final Mark < 5.0) can do a retake exam.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Attendance	5%	0.5	0.02	1
Exam	40%	2.5	0.1	8, 5, 3, 6, 9
Project	55%	6	0.24	1, 8, 4, 5, 7, 3, 2, 9, 11, 10

Bibliography

1. Rafael C. Gonzalez, Richard E. Woods*, "Digital Image Processing", 3rd Edition.*
2. David Marr, "*Vision: A Computational Investigation into the Human Representation and Processing of Visual Information"*, Freeman, 1982.
3. Richard Szeliski, "*Computer Vision: Algorithms and Applications"*, Springer-Verlag New York, Inc. New York, USA 2010.

Software

Tools for Python programming with special attention to computer vision and image processing libraries